Dr. Srikant Sukumar   **Curriculum Vitae**

CONTACT INFORMATION

Assistant Professor
Systems and Control Engineering
Indian Institute of Technology Bombay
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DATE OF BIRTH

July 17, 1981

OBJECTIVE

Support application for Associate Professor in Systems & Control

RESEARCH INTERESTS

Nonlinear Control Theory, Robust and Adaptive Control, Optimal Control Theory and Optimization, Switched and Hybrid Systems, Nonlinear Dynamics, Control of Unmanned Autonomous Vehicles, Geometric Control, Guidance, Navigation and Control of Spacecrafts, Control Applications to Bio-Mechanical Systems, Cooperative and Networked Control.

EDUCATION

The University of Texas at Austin, Austin, TX

Ph.D., Aerospace Engineering, May 2011   GPA: 4.0 (4.0 scale)
- Thesis Topic: Persistent Filters for Controller and Observer design in Singular Gain Systems
- Adviser: Professor Maruthi R. Akella
- Area of Study: Control Theory

Arizona State University, Tempe, AZ

M.S., Mechanical Engineering, August 2006   GPA: 3.88 (4.0 scale)
- Thesis Topic: System Identification and Inertia Compensated Control of a Planar Manipulator
- Adviser: Professor Thomas Sugar
- Area of Study: Control Engineering

Indian Institute of Technology, Roorkee, India

B.Tech., Mechanical Engineering, June 2003   GPA: 8.89 (10.0 scale)
- Class Rank 2
- Entrance Through National Level Competitive Examination with 0.3% Success Rate
- B. Tech Project: Modelling and Stability Analysis of Rail Coach Wheel Wear.

PROFESSIONAL EXPERIENCE

Indian Institute of Technology Bombay, Mumbai, India

<u>Assistant Professor</u>   **November 2011 to present**
- Establishing a research program with focus on Adaptive, Cooperative and Decentralized Control involving graduate student research advising.
- Current research projects include,
  - Quadcopter control with attitude and control constraints.
  - Decentralized adaptive coverage control of robots.
  - Event-triggered control over switching graph networks.
  - Sparse control of single and multiple agent systems.
  - Spacecraft cooperative formation control with only line of sight information.

The University of Texas at Austin, Austin, TX

<u>Postdoctoral Researcher</u>   **May 2011 to September 2011**
- Project: Autonomous navigation using large scale sensor swarms
- Funding agency: NASA Johnson Space Center
- Designed exponential observer for combining sensor swarms with intermittent data loss.
- Algorithms to be implemented on a UAV platform. Carried out simulations on MATLAB.

Tata Motors India Ltd., Lucknow, India

<u>Graduate Engineering Trainee</u>   **July 2003 to June 2004**
- Involved in process planning and process control for new gear box manufacturing assembly line setup for Tata Nano.

Ford India Private Ltd., Chennai, India

<u>Summer Intern</u>   **May 2002 to July 2002**
- Engineering Support in the Body Shop on the Ford Ikon Compact Car Assembly Line.

REFEREED JOURNAL PUBLICATIONS

[1] Nilanjan Roy Chowdhury, Srikant Sukumar, Mohamed Maghenem, and Antonio Loría. On the estimation of the consensus rate of convergence in graphs with persistent interconnections. International Journal of Control, (just-accepted):1–26, 2017

[2] Rakesh R Warier, Arpita Sinha, and Srikant Sukumar. Line-of-sight based formation keeping and attitude control of two spacecraft. Acta Astronautica, 127:131–140, 2016b

[3] Rakesh R Warier, Arpita Sinha, and Srikant Sukumar. Line-of-sight based spacecraft attitude and position tracking control. European Journal of Control, 2016a

[4] Srikant Sukumar and Debasish Chatterjee. A jammers perspective of reachability and lq optimal control. Automatica, 70:295–302, 2016

[5] Nilanjan Roy Chowdhury, Srikant Sukumar, and Niranjan Balachandran. Persistence based convergence rate analysis of consensus protocols for dynamic graph networks. European Journal of Control, 29:33–43, 2016

[6] Sukumar Srikant and Maruthi Akella. Arbitrarily fast exponentially stabilizing controller for multi-input, persistently exciting singular control gain systems. Automatica, 54:279–283, 2015

[7] Divya Thakur, Sukumar Srikant, and Maruthi R Akella. Adaptive attitude-tracking control of spacecraft with uncertain time-varying inertia parameters. Journal of Guidance, Control, and Dynamics, 38(1):41–52, 2014

[8] Srikant Sukumar and Maruthi R. Akella. Persistence filters for estimation: Applications to control in shared-sensing reversible transducer systems. Journal of Dynamic Systems, Measurement, and Control, 134(4):041012, 2012

[9] S. Srikant and M. R. Akella. Precision attitude stabilization: incorporating rise and fall times in gas-based thrusters. AIAA Journal of Guidance, Control and Dynamics, 34(1):317–323, February 2011

[10] S. Srikant, JL Wagner, A. Valdivia, MR Akella, and N. Clemens. Unstart Detection in a Simplified-Geometry Hypersonic Inlet–Isolator Flow. Journal of propulsion and power, 26(5):1059–1071, 2010. ISSN 0748-4658

[11] S. Srikant and M. R. Akella. Persistence filter-based control for systems with time-varying control gains. Systems & Control Letters, 58(6):413–420, 2009

CONFERENCE
PRESENTATIONS

[12] Relative Attitude Tracking Control of Multiple Spacecraft with Unknown Inertia Using Line-Of-Sight Measurements - A. K. Subramanian, R. Warier, S. Srikant, Indian Control Conference (ICC) 2017, Jan 4-6, 2017

[13] Relative Attitude Tracking Control of Multiple Spacecraft with Unknown Inertia Using Line-Of-Sight Measurements - R. Warier, S. Srikant, Indian Control Conference (ICC) 2017, Jan 4-6, 2017

[14] Attitude and Position Tracking of a Underwater Rigid Body - A. Arun Kumar, R. Warier, S. Srikant, 10th IFAC Symposium on Nonlinear Control Systems (NOLCOS 2016), August 23-25, 2016

[15] Decentralized Adaptive Coverage Control of Nonholonomic Mobile Robots - R. A. Razak, S. Srikant, 10th IFAC Symposium on Nonlinear Control Systems (NOLCOS 2016), August 23-25, 2016

[16] Consensus analysis of double integrator agents with persistent interaction graphs - N. Roy Chowdhury, S. Srikant, Australian Control Conference (AUCC), November 5-6, 2015

[17] Lyapunov based Attitude constrained control of Spacecraft - M. Bujarbaruah, S. Srikant, AAS/AIAA Astrodynamics Conference, Vail, Colorado in August 9-13, 2015

[18] A comparative study of persistence based convergence rate estimates to Consensus - N. Roy Chowdhury, S. Srikant, 1st Conference on Modeling, Identification and Control of Nonlinear Systems (MICNON), June 24-26, 2015

[19] Line of Sight Based Spacecraft Formation Control under Gravity - R. Warier, A. Sinha, S. Srikant, Indian Control Conference, January 5-7, 2015

[20] Spacecraft Attitude Synchronization And Formation Keeping Using Line Of Sight Measurements - R. Warier, A. Sinha, S. Srikant, IFAC World Congress, August 24-29, 2014

[21] Persistence based analysis of consensus protocols for dynamics graph networks- N. Roy Chowdhury, S. Srikant, European Control Conference, June 24-27, 2014

[22] Lyapunov Function Based Steering Law for Generalized Voronoi Diagram (GVD) Construction by a Mobile Robot - G. K. Arunkumar, S. Srikant, L. Vachhani, ACODS 2014

[23] Relative Attitude Trajectory Tracking Using Line Of Sight Measurements Under Spacecraft Position Dynamics - R. Warier, A. Sinha, S. Srikant, ACODS 2014

[24] Adaptive attitude-tracking control of spacecraft with uncertain time-varying inertia parameters - D. Thakur, S. Srikant and M.R. Akella, AAS/AIAA Astrodynamics Specialist Conference, August 11-15 2013

[25] Stabilizing controller for multi-input, singular control gain systems S. Srikant, M. R. Akella, 51st IEEE Conference on Decision and Control, December 10-13, 2012.

[26] Persistence Filters for State Observation and Feedback Control in Shared-Sensing Based Reversible Transducer Systems S. Srikant, M. R. Akella, International Conference on Computational & Experimental Engineering and Sciences (ICCES11), April 18-21, 2011.

[27] High-frequency pressure measurements for unstart detection in scramjet isolators - Jeffrey M. Donbar, Graham J. Linn, Srikant Sukumar, Maruthi R. Akella, 46th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, 25-28 July, 2010.

[28] Persistence filter based attitude stabilization of micro-satellites with variable amplitude thrusters S. Srikant, M. R. Akella, 20th AAS/AIAA Space Flight Mechanics Meeting, February 14-17, 2010, In Proceedings.

[29] Shock stabilization in a hypersonic inlet using robust adaptive feedback control - J. Hatlelid, S. Srikant, M. R. Akella, Air Force Office of Scientific Research (AFOSR) MURI Review Meeting, October 29-30, 2008, Closed Conference.

[30] Persistence filters for non-feedback linearizable systems with time-varying control gains S. Srikant, M. R. Akella, 18th AAS/AIAA Space Flight Mechanics Meeting, January 27-31, 2008, In Proceedings.

BOOKS/CHAPTERS [31] Adventures on the Interface of Mechanics and Control, chapter "Persistence filters for state observation and feedback control in shared-sensing based reversible transducer systems". Tech Science Press, 2012

GRANTS   Primary Investigator, "Control of indirectly and intermittently actuated systems", IRCC and IIT Bombay Seed Grant, INR 20,00,000, June 1, 2012 to May 31, 2015.

Primary Investigator, "Nonlinear Feedback Control Design For Quadcopter Trajectory Tracking", Flipkart Internet Pvt. Ltd., INR 3,30,00, Oct 20, 2015 to Oct 19, 2017.

Co-PI, "Vision based motion planning for a 3D crane", Konecranes Shared Services India Pvt. Ltd., INR 7,0,000, Aug 18, 2015 to Aug 17, 2017.

REFEREE SERVICES   I have been involved in reviewing articles for publication in the following international journals and conferences,
- AIAA Journal of Guidance Control and Dynamics American Institute of Aeronautics and Astronautics publication.
- Automatica Elsevier publication.
- Systems & Control Letters Elsevier Publication.
- IEEE Transactions on Automatic Control Institute of Electrical and Electronics Engineers publication.
- International Journal of Systems Science - Taylor and Francis publications
- International Journal of Robust and Nonlinear Control - Wiley publications
- European Control Conference 2014

RESEARCH APPOINTMENTS   **The University of Texas at Austin**, Austin, TX

Research Assistant   **January 2010 to August 2010**

- Project: Autonomous navigation using large scale sensor swarms.
- Primary Investigator: Dr. Maruthi R. Akella
- Supported by: NASA Johnson Space Center.
- Designed exponential observer for combining sensor swarms with intermittent data loss. Algorithms to be implemented on a UAV platform. Carried out simulations on MATLAB. Work resulted in one journal and one conference publication.

Research Assistant   **August 2008 to December 2009**

- Project: Feedback control for unstart prevention in dual-mode scramjet engines.
- Primary Investigators: Dr. Maruthi R. Akella and Dr. N. T. Clemens

- Supported by: Air Force Office of Scientific Research.
- Carried out feasibility studies for active control of flow in scramjet engines with high-frequency pressure transducers. Interacted with and assisted in development of LabVIEW based real-time data acquisition and control system. Also formulated shock detection algorithms based on a moving-window Fast Fourier Transform of pressure data and coded them in MATLAB. Work resulted in one journal and one conference publication.

Arizona State University, Tempe, AZ

<u>Research Assistant</u>   **June 2005 to May 2006**

- Project: Accurate force field generation on the In Motion 2 planar manipulator for subject testing in motor control studies.
- Primary Investigators: Dr. Deric Wisleder and Dr. George Stelmach
- Supported by: National Science Foundation (NSF) and National Institutes of Health (NIH)
- Implemented force fields in real-time in C with RT-Linux kernel system. Also generated Tcl/Tk based graphical user interface. System identification carried out to cancel robot inertia contribution at end effector.

TEACHING EXPERIENCE

Indian Institute of Technology Bombay, Mumbai, India

<u>Instructor</u>   **January 2017 to May 2017**

- Instructor for SC 618: Analytical and Geometric Dynamics
  - Students will be taught topics such as Newtonian mechanics, kinematics, Lagrangian/Hamiltonian dynamics and Rigid Body dynamics, Manifolds, Tangent and Cotangent spaces, Vector fields and forms, Mechanics on Manifolds, Symmetry and Reduction, Poisson Manifolds.
  - The teaching process involves classroom theory sessions involving illustrative problem solving.
  - Involved in lecturing, grading quizzes and final evaluation.

<u>Instructor</u>   **July 2016 to November 2016**

- Instructor for SC 201: Mathematical Structures for Systems and Control
  - Students were taught topics such as Groups, Rings, Vector Spaces, Linear Functionals, Tensors, Norms, Continuity & Uniform Continuity, Countability, Limit points, Convergence, Compactness, Calculus of variations.
  - The teaching process involved classroom theory sessions involving illustrative problem solving.
  - Involved in lecturing, grading quizzes and final evaluation.

<u>Instructor</u>   **July 2014/15 to November 2014/15**

- Part Instructor for SC 201: Mathematical Structures for Systems and Control
  - Students were taught topics such as Groups, Rings, Vector Spaces, Linear Functionals, Tensors, Norms, Continuity & Uniform Continuity, Countability, Limit points, Convergence, Compactness, Calculus of variations.
  - The teaching process involved classroom theory sessions involving illustrative problem solving.
  - Involved in lecturing, grading quizzes and final evaluation.

<u>Instructor</u>   **July 2012-14 to November 2012-14**

- Part instructor for SC 618: Analytical and Geometric Dynamics
  - Students were taught topics such as Newtonian mechanics, kinematics, Lagrangian/Hamiltonian dynamics and Rigid Body dynamics.
  - The teaching process involved classroom theory sessions involving illustrative problem solving.
  - Involved in lecturing, grading quizzes and final evaluation.

<u>Instructor</u>   **July 2012/13 to November 2012/13**

- Part instructor for SC 625: Systems Theory
  - I was involved in teaching topics in Linear Systems Theory at a graduate level.
  - Topics included, Jordan blocks, State-space models, Transition matrix, controllability, observability, internal stability and linear state feedback.
  - Responsible for lectures, grading quizzes and final evaluation.

<u>Instructor</u>   **January 2012/13/15/16 to May 2012/13/15/16**

- Instructor for SC 617: Adaptive Control Theory
  - Students learnt topics such as, Lyapunov stability analysis and Barbalat's Lemma, signal-chasing, parameter adaptive control including the certainty equivalence and modern non-certainty equivalence paradigms, high-frequency gain adaptation, parameter projection in adaptive control and adaptive observers.
  - Responsible for lectures, grading quizzes and final evaluation.

<u>Instructor</u>   **January 2013/14 to May 2013/14**

- Part instructor for SC 626: Systems and Control Laboratory
  - Students conducted various experiments relevant to systems and controlling the same. These setups including inverted pendulum, control moment gyroscope, plant emulator, 3D crane, 2-DOF helicopters and other instructional lab setups.
  - I was responsible for ensuring that the setups were in working condition, assist students in carrying out experiments, describing the theoretical aspects of each setup and final evaluations.

<u>Instructor</u>   **July 2013/14/15 to November 2013/14/15**

- Part instructor for SC 301: Linear and Nonlinear Systems
  - Taught the linear systems component for a institute minor course in linear and nonlinear systems.
  - Topics included, Existence and Uniqueness of solutions to ODE, State-space models, Transition matrix, controllability, observability, internal stability and linear state feedback.
  - Responsible for lectures, quiz and homework preparation, and evaluation.

The University of Texas at Austin, Austin, TX

<u>Teaching Assistant</u>   **August 2006 to May 2008**

- Teaching Assistant for EM 306: Statics - responsible for conducting problem discussion sessions, holding office hours for resolving queries, creating and grading quizzes and homework.
- Teaching Assistant for EM 311M: Dynamics - responsible for conducting problem discussion sessions, holding office hours for resolving queries and grading quizzes and homework.
- Teaching Assistant for ASE 330M: Linear Systems Analysis - responsible for creating homework solutions, grading of homeworks and office hours to resolve queries.
- Teaching Assistant for ASE 269K: Measurements and Instrumentation Laboratory - responsible for organizing, providing instructions and conducting laboratory experiments, ensuring availability of sufficient number of lab setups.

Arizona State University, Tempe, AZ

<u>Teaching Assistant</u>   **August 2004 to May 2005**

- Teaching Assistant for MAE 318: Control Systems Design - responsible for conducting problem discussion sessions, office hours to resolve doubts, creating and grading quizzes/assignments.

STUDENT
ADVISING

<u>PhD Candidates</u>

- Nilanjan R. Choudhury - Consensus analysis of dynamically interacting agents under communication constraints using notions of persistence of excitation.
- Rakesh Warrier (co-advised with Arpita Sinha) - Satellite attitude consensus and formation flying using line of sight measurements.
- Rihab A. Razak (co-advised with Hoam Chung, Monash University)- Decentralized coverage control using mobile differential drive robots.
- Arun K. Subramanian - Event triggered control for consensus over switching graph networks.

<u>Masters Candidates</u>

- G. K. Arunkumar (co-advised with Leena Vachhani)- Robot based Generalized Voronoi Diagram tracing using range sensor measurements - Graduated, June 2014.
- M. Abhilash (co-advised with H. Hablani) - Singularity avoidance in Control Moment Gyroscopes - converted to PhD in Aerospace Engg.
- Monimoy Bujarbaruah (Aerospace Engg.) - Nonlinear control design for quadcopter obeying orientation and actuator constraints - graduated June 2016
- Devyesh Tandon (Aerospace Engg.) - Consensus of multi-agent systems under constant sensor bias.
- Bhanupriya Purohit - Quadrotor trajectory generation and control under attitiude constraints.

<u>Independent Research Assocates</u>

- Siddharth Mulay - Microcontroller based HCCI engine control, Nonlinear control design for quadcopter obeying orientation and actuator constraints.

Undergraduate Projects

- Manvi Dhawan - Design and implementation of a pure attitude controller for a quadcopter based on the open-source Arduino platform.
- Divyam Rastogi - Quadcopter control design for autmatic take-off and implementation in an open source Arduino based Quadcopter.
- Sai Hemanth - Implementation of leader-follower formation control algorithm on differential drive robots.

PROFESSIONAL
MEMBERSHIPS

- IEEE Member, since December 2010.
- AIAA Member, August 2009 – July 2011, since Aug 2016
- Arizona State University Alumni Association Member, since June 2006.
- University of Texas at Austin Alumni Member, since June 2011.

SERVICE AND
OUTREACH

- Associate Editor, American Control Conference (ACC) 2017.
- IEEE Technical Committee in Aerospace Control Member since Nov. 2016.
- Lectured on "modern areas of nonlinear control research" at IISc Bangalore in ISRO-IISc sponsored Workshop on Topics in Aerospace Research, Feb 2016
- Organized short lecture series on "Adaptive Feedback Control" in Systems and Control Winter School organized in January 2012 and January 2016.
- IDPC member from Jan 2013 to Dec 2015
- Conducted short-term course in "Adaptive Control" under IIT Bombay's Quality Improvement Program intended for college teachers in May 2013 and May 2015.
- PhD entrance coordinator for Spring 2013 and committee member for Autumn 2012.

AWARDS AND
HONORS

- October 2015 September 2016 - Excellent Reviewer for the year, AIAA Journal of Guidance, Control and Dynamics.
- April 2015 – April 2019 - Max Planck Mobility Fellowship, IGSTC and Max Planck Institute.
- December 2011 - December 2015 Young Faculty Award, Indian Institute of Technology Bombay.
- September 2010 - May 2011, Homer Lindsay Bruce Endowed Graduate Fellowship, The University of Texas at Austin.
- August 2006 - May 2007, Deans Preemptive Fellowship, The University of Texas at Austin.
- Jan 2000 - Jan 2003, University Merit Scholarship for excellent academic performance, IIT, Roorkee.

HARDWARE AND
SOFTWARE SKILLS

Instrumentation, Control, Data Acquisition, Test, and Measurement:
- RT Linux, Simulink, LabVIEW and other National Instruments control and data acquisition hardware and software

Computer Programming:
- C, C++, Tcl/Tk script, MATLAB, Maple, Mathematica, HTML scripting and others

Optimization Routines:
- Solvers including SNOPT, CPLEX, KNITRO, BFGS and PR algorithms. Interfaces used were web based NEOS-SCIP, AMPL-NEOS and MATLAB

MATLAB skill set:
- Linear algebra, Fourier transforms, ODE solvers, nonlinear numerical methods, polynomials, statistics, N-dimensional filters, optimization algorithms
- Toolboxes: communications, control system, filter design, signal processing, system identification, optimization

Productivity Applications:
- T$_E$X (L^{A}T$_E$X, B$_{IB}$T$_E$X, Tikz, Beamer), Vim, emacs, most common productivity packages (for Windows, OS X, and Linux platforms)

Operating Systems:
- Microsoft Windows family, Apple OS X, Linux, Ubuntu

REFERENCES AVAILABLE TO CONTACT   Available upon request.